IB MYP YEAR 5

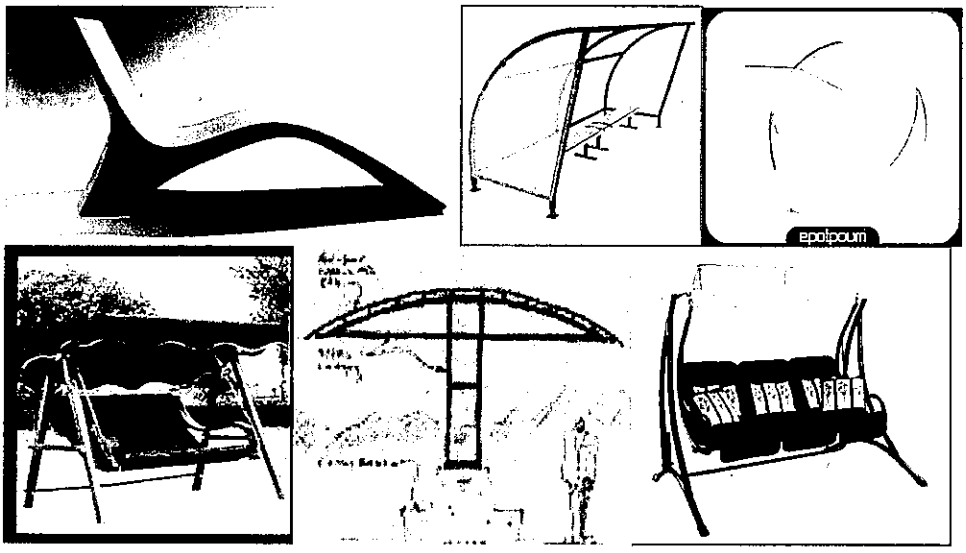
ASSESSMENT TASK

The water front bench

Subject:	Y10 Extended Mathematics	**Name (Class):**	Jessi Lui (10J)
Topic:	Polynomials	**Reading material:**	Chapter 2 & 6 in Book A
Date of task assigned:	22nd September, 2011	**Due Date:**	6th October, 2011
Submission of task:	Please submit a print copy of the assessment to your Maths teacher on or before Thursday, 6th October 2011 at 0840.		

This task assesses Criteria A, C, & D.

Task Brief: Design a water front bench with a canopy.



Product
Two parts

Canopy ->
+
Seat->

ADVICE:
Read the criteria descriptors and task-specific rubrics carefully before you start your work. This will give you a clear understanding of what is required and what a high quality piece of work for this task must include.
This way you give yourself the best chance of achieving the highest levels in this task.

Please attach these sheets to your final report.

The Task

Background

You have been hired as a new designer at the *Polynomial Seating Company (PSC)*. The company is world famous for designing and manufacturing creative and attractive seats and benches, mainly for outdoor use. The Manager is giving you a special task for a new client.

You are given the task of designing a chair/bench for use outdoors. The client wants your designs quite quickly. So does the manufacturing department of PSC, as they will want to start production quite soon.

The bench should be (a) comfortable, (b) suitable for keeping off the sun and the rain and (c) have a profile that is highly mathematical in shape – in fact it should use functions that you have met in this topic of Polynomials (i.e. quadratics and cubics).

Of course, you won't ***build*** the bench, but you will come up with the functions (equations) that will define the shape of the bench.

You will submit a report that outlines the development of your design. The report will be assessed using MYP Assessment Criteria A, C and D, and the paragraphs below expand on this.

Criterion A:

Here you show your ***knowledge and understanding*** of quadratic and cubic equations and their graphs. You MUST provide all the appropriate information about your design specification including:

- Accurate plots of all graphs, showing the important features of the design; ← where everything fits. intercepts.
- Sets of equations describing all curves used and listing the range of x-values; $x \in [-5, 8]$ from where to where.
- The process (mathematics) by which you came up with the equations used in the design including possible modifications that could be made if requested by the client. : By transformation ; show steps.

In order to score top marks in this criterion, you should show how you have used your knowledge in ***unfamiliar situations*** by embedding and developing at least one function that has not been covered in class, such as trigonometric, exponential, logarithmic etc.

Criterion C:

Your design needs to be ***communicated*** effectively for your manager, the client, and the manufacturing department who will use it to make the actual bench. This means that all graphs will be clearly labeled, and all appropriate diagrams and charts will be explained. Equations will have to connect sensibly to appropriate units of distance.

Any software used will have to be cited and, if necessary, explained. Software:

Criterion D:

Before you begin your design, it is important that you come up with a set of specifications so the client can see how comfortable, sheltered, and creative your design will be. You need to ***reflect*** (and possibly research) on associated real-life issues, such as: → material:

- People's sizes and comfort levels; → # of users:
- How people sit or lounge;
- How the sun and the rain act; → where the sun is/ when @ waterfront.
- How easily the bench might be stored away;
- Any other features that you believe may be relevant to the product. → shoulder width, two different usage, posture?

Once you have finished your design, please ***evaluate*** it against the specifications you listed before you began. Consider how well your model fits your specifications by checking the degree of accuracy (possibly percentage error or sig. fig.). Because the client wants the initial design in just a few days, there may well be a number of things you cannot do. If you had more time, suggest what other things you might do to improve your product? What different mathematical methods might you have tried?

:) Reflection –

:) Improvement –

:) 'Supervisor' meeting –

Assessment Criteria for Y10 Extended Maths Bench Assessment

Criterion A

Levels	Task-Specific Rubric	Official IB Descriptors
0	The student does not reach a standard described by any of the descriptors given below.	
1-2	The student generally makes appropriate selections of one or more simple functions (such as y=mx+b, $y = x^2$) and manipulates them in to form a chair/bench.	The student **generally** makes appropriate deductions when solving **simple** problems in **familiar** contexts.
3-4	The student generally makes appropriate selections of two or more non-linear functions (eg quadratics or cubics) and manipulates them to form a chair/bench with a canopy.	The student generally makes appropriate deductions when solving **more complex** problems in **familiar** contexts.
5-6	The student generally makes appropriate and accurate selections of three or more sophisticated functions (eg higher order polynomials, trigonometric functions) and manipulates them to form a chair/bench with a canopy.	The student **generally** makes appropriate deductions when solving **challenging** problems in a **variety** of **familiar** contexts.
7-8	The student consistently makes appropriate and accurate selections of four or more sophisticated (eg higher order polynomials or trig) functions and at least one unfamiliar one (eg circles, roots, exponentials, logs, hyperbolas etc) to form a chair/bench with a canopy.	The student **consistently** makes appropriate deductions when solving **challenging** problems in a **variety** of contexts including **unfamiliar situations**.

Criterion C

Levels	Task-Specific Rubric	Official IB Descriptors
0	The student does not reach a standard described by any of the descriptors given below.	
1-2	Some very basic equations are offered and described. There are some appropriate diagrams and graphs. There is a basic narrative that describes the processes used.	The student shows **basic use** of mathematical language and/or forms of mathematical representation. The lines of reasoning are **difficult to follow.**
3-4	Equations used are generally clearly explained. Clear, accurate and relevant graphs, and/or charts and tables are provided. It is generally easy to see how these diagrams describe the development of the chair/bench design. Key vocabulary is used. Narrative is generally accurate.	The student shows **sufficient use** of mathematical language and forms of mathematical representation. The lines of reasoning are **clear though not always logical or complete**. The student moves between different forms of representation with **some success**.
5-6	Several graphs and diagrams are offered to show the development of the chair/bench. Graphs are accurate and detailed. Equations are provided which match the important features of the graphs. It would be possible for PSC engineers to produce the chair/bench from the diagrams. The narrative is very clear.	The student shows **good** use of mathematical language **and** forms of mathematical representation. The lines of reasoning are **concise, logical** and **complete**. The student moves **effectively** between different forms of representation.

from side

* where the ground contacts with sections.

x-axis = ground.

Criterion D

Levels	Task-Specific Rubric	Official IB Descriptors
0	The student does not reach a standard described by any of the descriptors given below.	
1-2	There has been a limited amount of relevant research undertaken. To some degree, the student has connected this research to the design of the chair/bench.	The student **attempts** to explain whether his/her results make sense in the context of the problem. The student **attempts to describe** the importance of his or her findings in connection to real life where appropriate.
3-4	The student has undertaken good, relevant research and has used this in the development of the chair/bench. The student has explained with justification how the design features of the chair/bench relate to real-life issues. The student tries to explain the accuracy of the equations.	The student **correctly but briefly explains** whether his/her results make sense in the context of the problem. The student **describes the importance of** his/her findings in connection to real life where appropriate. The student **attempts to justify** the degree of accuracy of his/her results where appropriate.
5-6	The student critically compares the final product with features identified at the design stage. Real-life issues associated with the design are developed. The student justifies appropriateness and accuracy of all equations and offers a critical review of the mathematical methods used, suggesting viable alternatives or improvements where appropriate.	The student **critically explains** whether his or her results make sense in the context of the problem. The student provides a **detailed explanation** of the importance of his/her findings in connection to real life where appropriate. The student **justifies** the degree of accuracy of his/her results where appropriate. The student suggests improvements to his/her method when necessary.

Introduction to task

The assessment is based on the topic polynomials. The task requires students to design a bench for outdoor use as a designer at a seating company. The client wants this bench to be comfortable, suitable for keeping off the sun and rain and uses many sophisticated mathematical functions.

The three criteria that we are assessed on are criterion A, C and D. This project will include many graphs with equations and x-value ranges. The entire creation process will be shown to the client. Moreover, a reflection and evaluation against the specifications will be provided.

Research work:

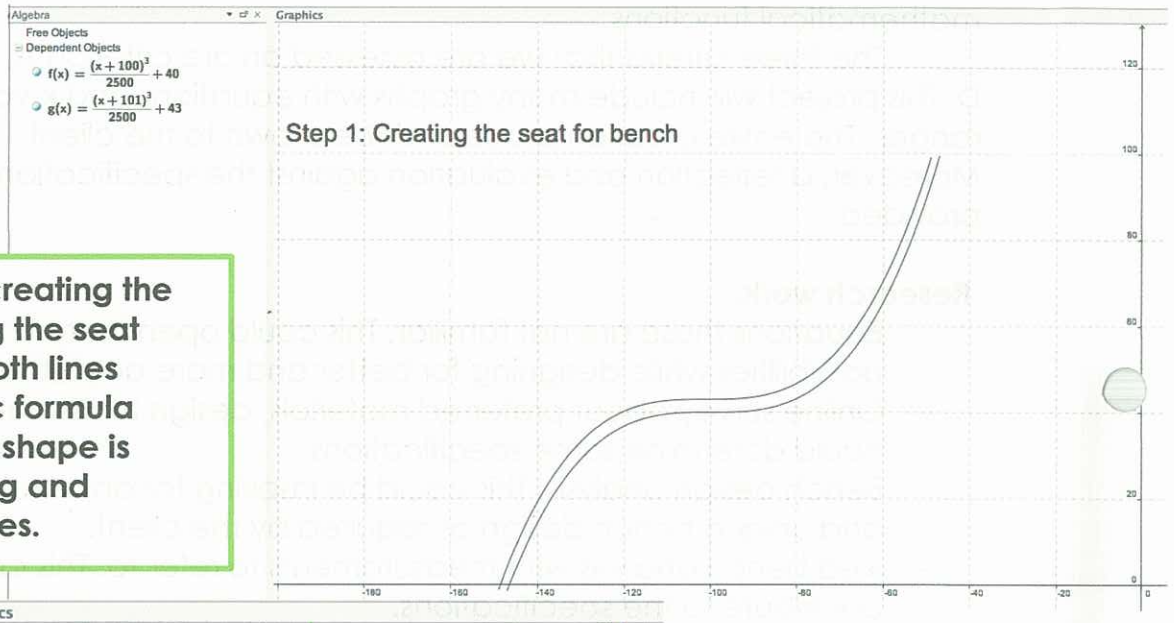
- Equations those are not familiar. This could open more possibilities while designing for better and more accurate lines.
- Online survey about preferred materials, design for bench. This could determine some specifications.
- Bench design analysis. This could be inspiring for an attractive and unique bench design as required by the client.
- Ikea bench analysis with measurements to refer to. This could contribute to the specifications.
- Measurement of target-users' body dimensions. This could provide first hand and accurate results to design a suitable product.
- Ergonomics of sitting. This could benefit the user's health and improve the product in general.

Table of Contents

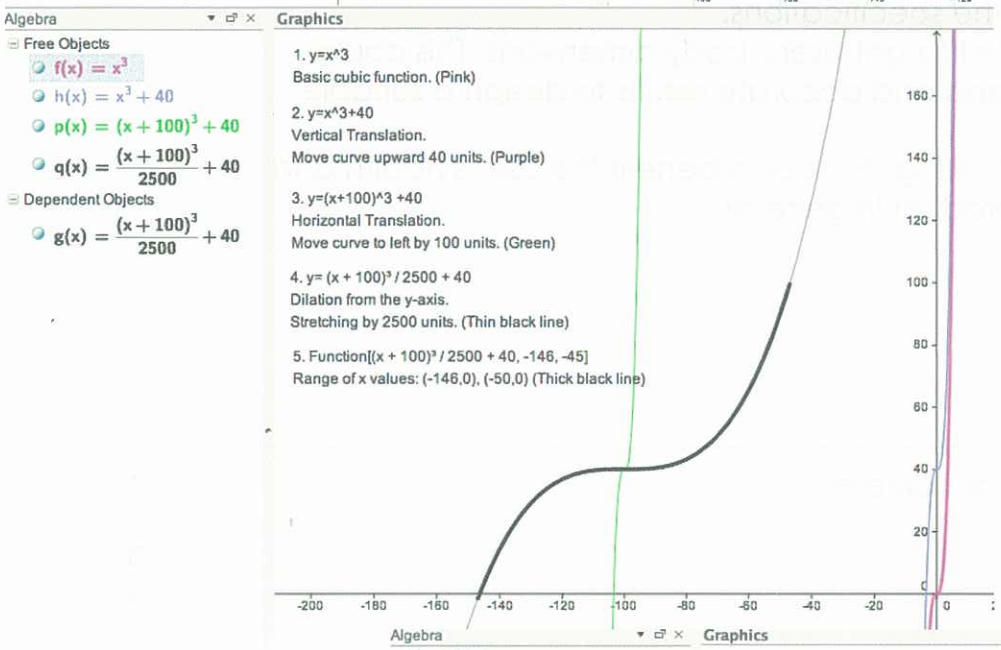
CONTENTS OF REPORT

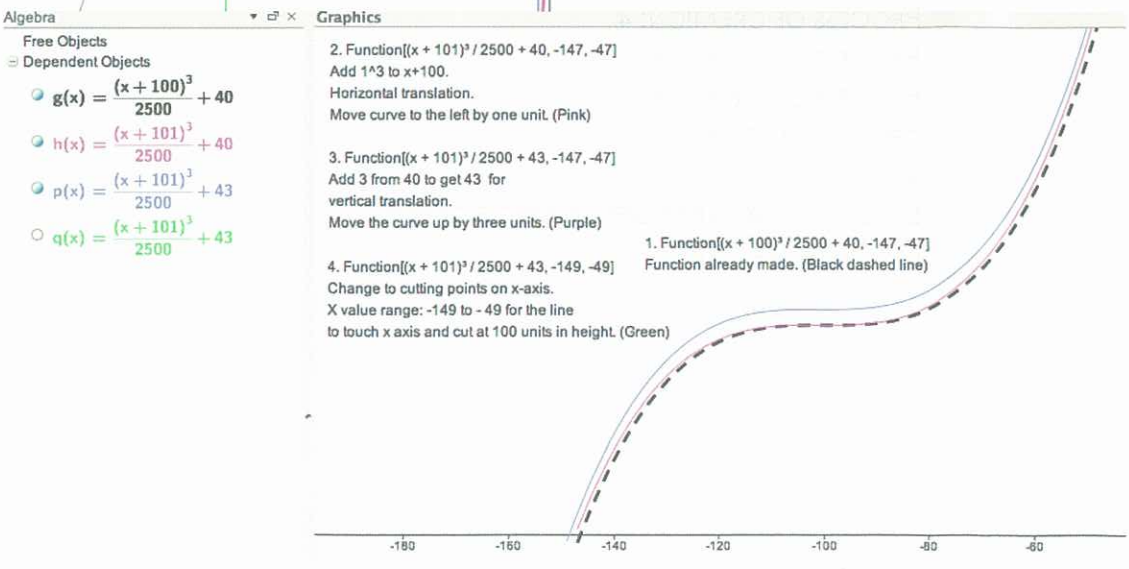
Process of creation

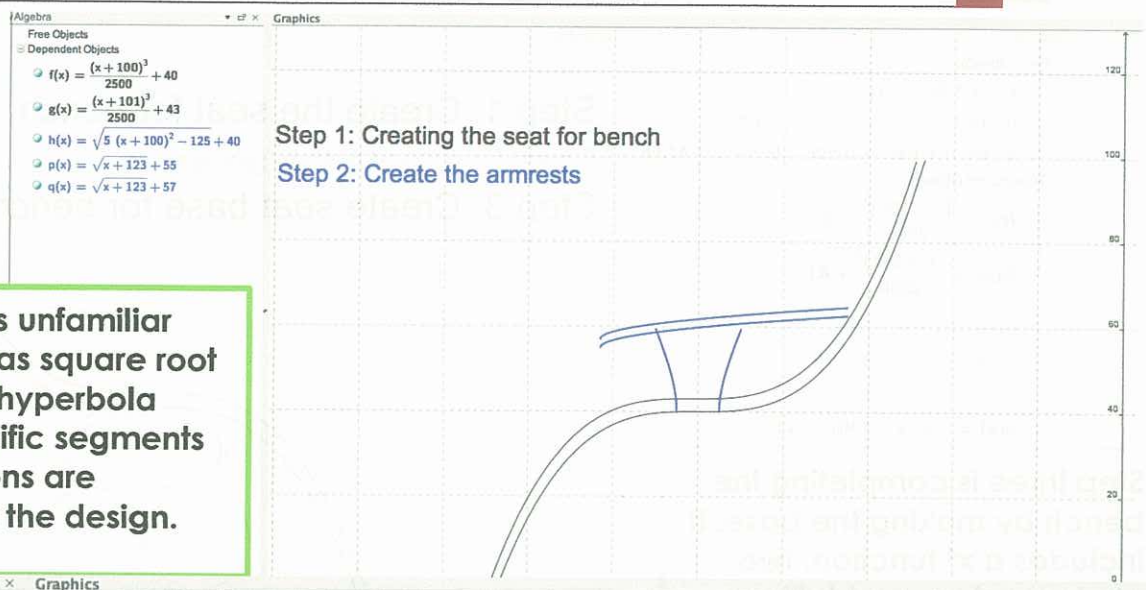
This process journal explains the process of coming up with functions, formulas and building the product. Formulas of each line can be seen on the left column under algebra. In addition, the grids and axis are useful for the PSC engineers to measure each section precisely to build the product.



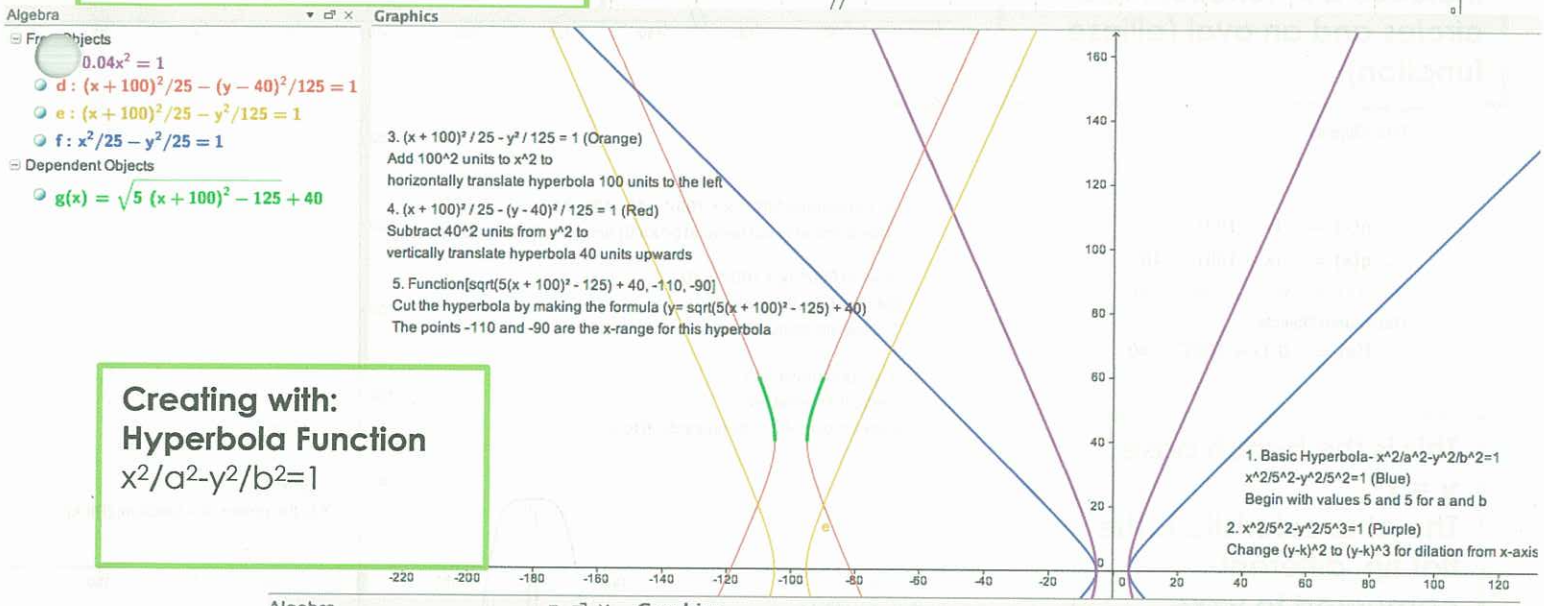
The first step to creating the bench is making the seat and backrest. Both lines begin with cubic formula (y=x^3) and the shape is seemly for resting and enjoying purposes.



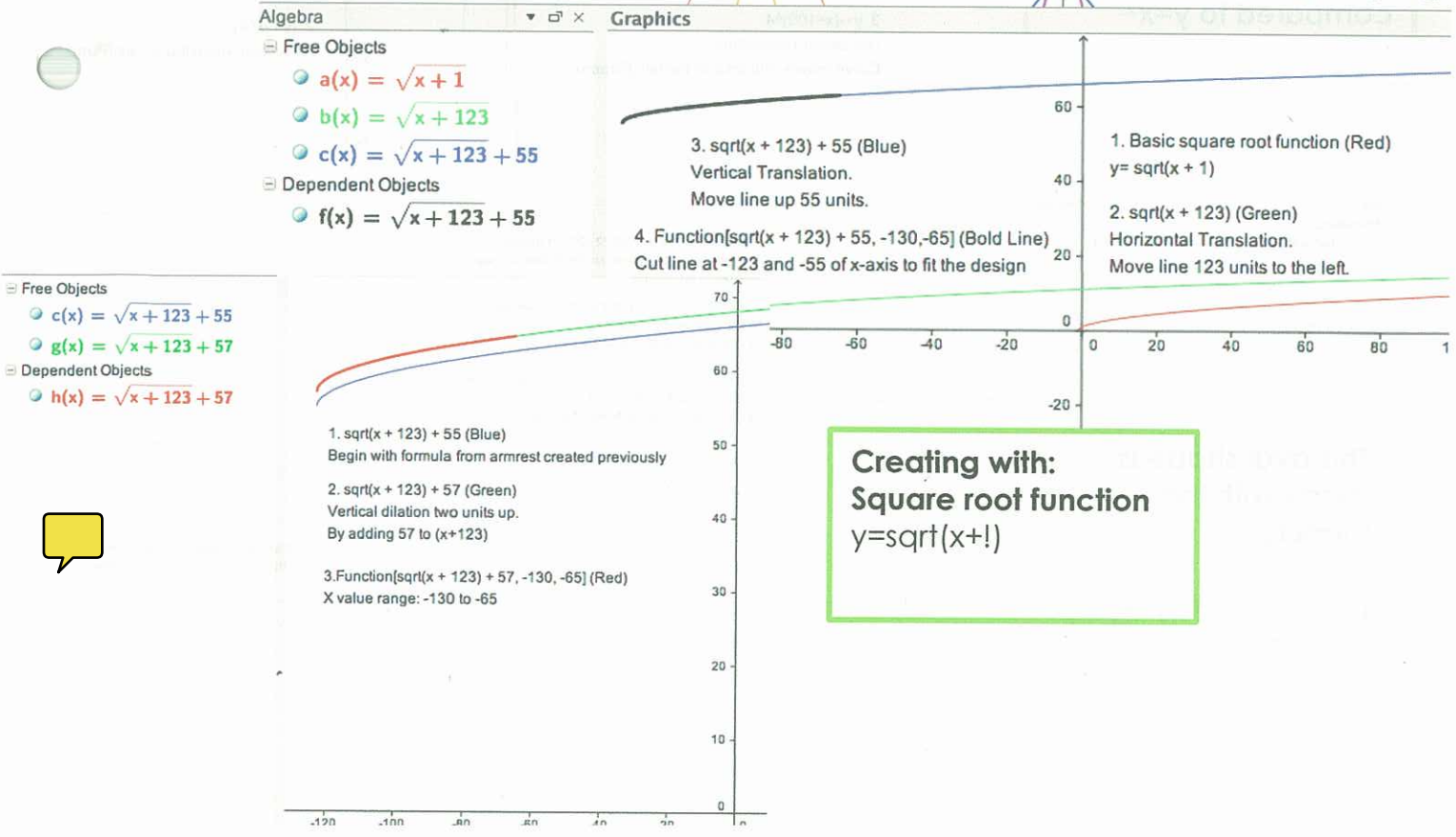




Step two utilizes unfamiliar functions such as square root function √ and hyperbola functions. Specific segments of these functions are selected to suit the design.



Creating with:
Hyperbola Function
$x^2/a^2-y^2/b^2=1$



Creating with:
Square root function
y=sqrt(x+!)

[MATH ASSESSMENT: CANOPY AND WATER BENCH DESIGN
JESSI LUI. Y10 JOY. MS. ECHO LI]

Algebra

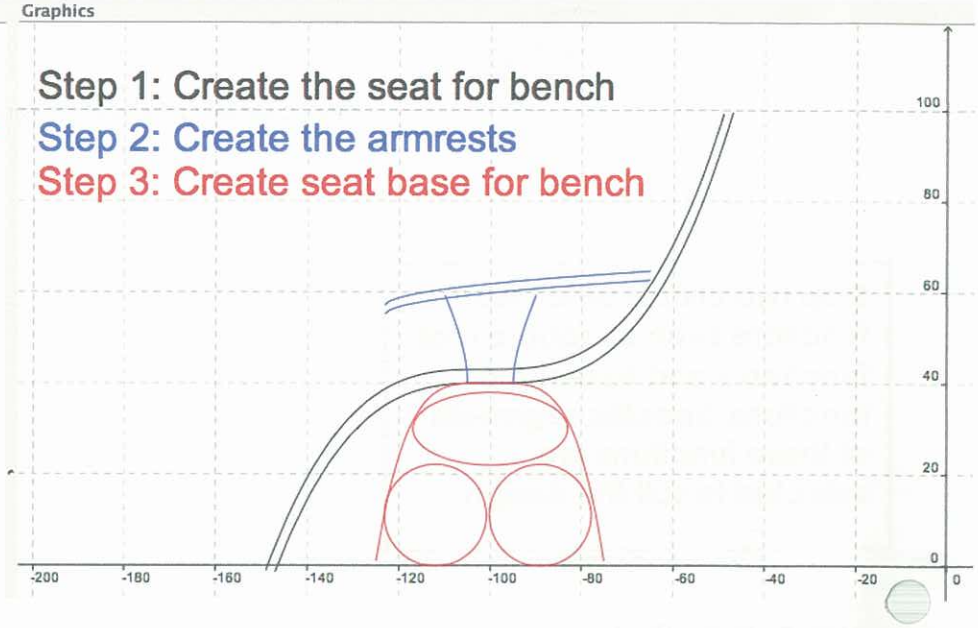
Free Objects

- $c : (x+89)^2 + (y-11)^2 = 125$
- $d : (x+112)^2 + (y-11)^2 = 125$
- $e : 0x^2 + 0.02y^2 + 0.69x - 0.94y = -47.66$

Dependent Objects

- $f(x) = \frac{(x+100)^3}{2500} + 40$
- $f_1(x) = \frac{(x+101)^3}{2500} + 43$
- $g(x) = \sqrt{5\,(x+100)^2 - 125} + 40$
- $h(x) = \sqrt{x+123} + 55$
- $p(x) = \sqrt{x+123} + 57$
- $q(x) = -0\,(x+100)^4 + 40$

Graphics



Step three is completing the bench by making the base. It includes a x^4 function, two circles and an oval (ellipse function).

Algebra

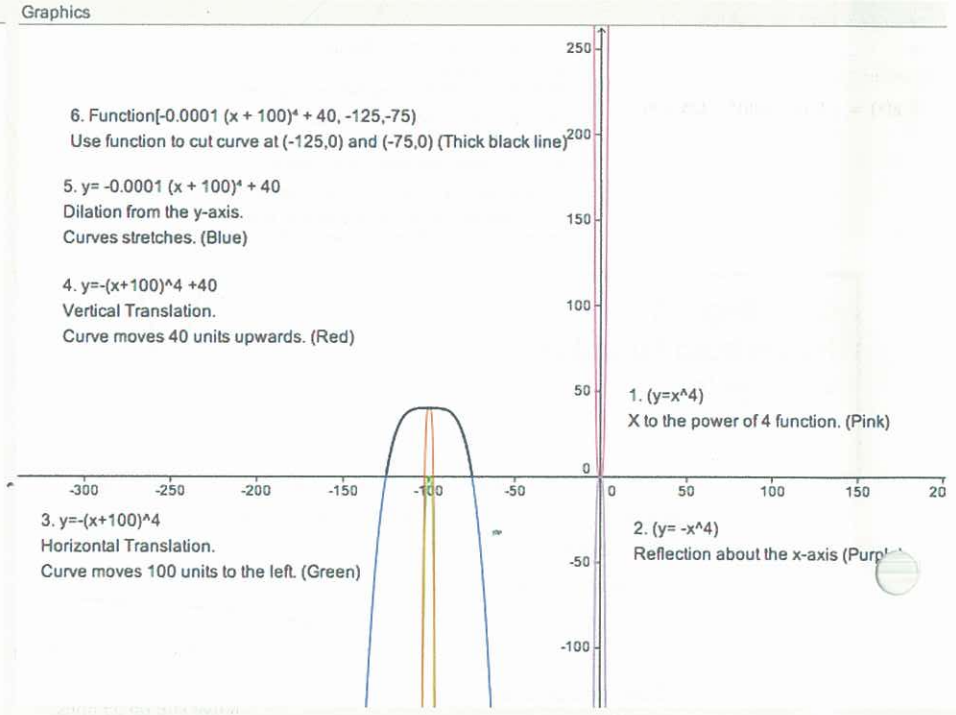
Free Objects

- $g(x) = x^4$
- $h(x) = -x^4$
- $p(x) = -(x+100)^4$
- $q(x) = -(x+100)^4 + 40$
- $r(x) = -0\,(x+100)^4 + 40$

Dependent Objects

- $f(x) = -0\,(x+100)^4 + 40$

Graphics



This is the bench base.
$y = x^4$
The characteristic is the flat tip, different compared to $y=x^2$.

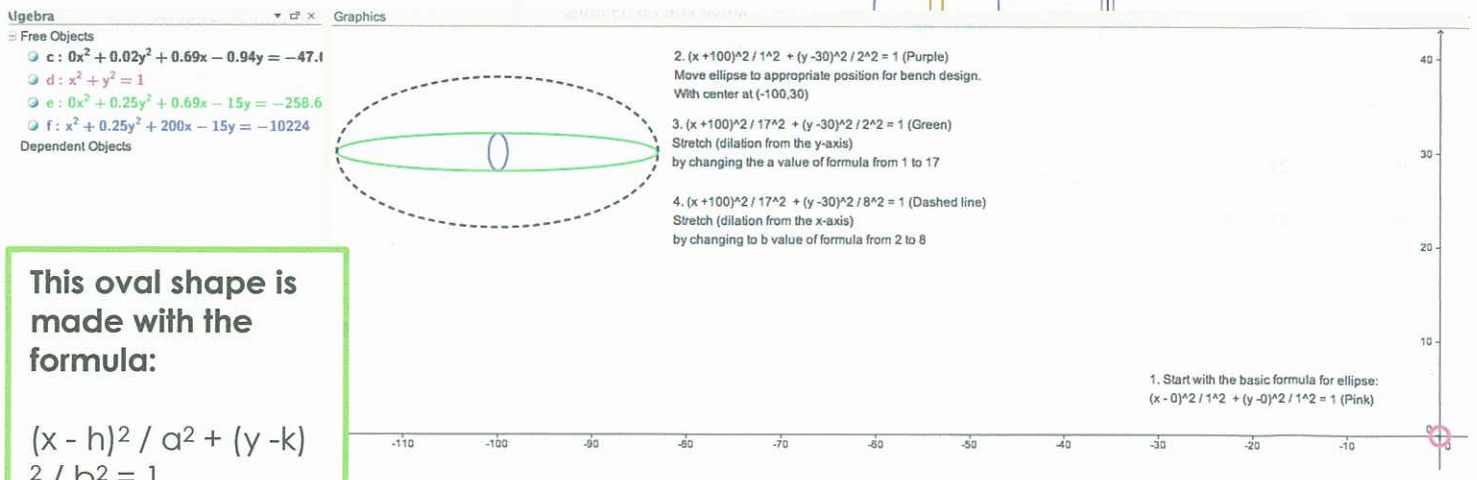
Algebra

Free Objects

- $c : 0x^2 + 0.02y^2 + 0.69x - 0.94y = -47.6$
- $d : x^2 + y^2 = 1$
- $e : 0x^2 + 0.25y^2 + 0.69x - 15y = -258.6$
- $f : x^2 + 0.25y^2 + 200x - 15y = -10224$

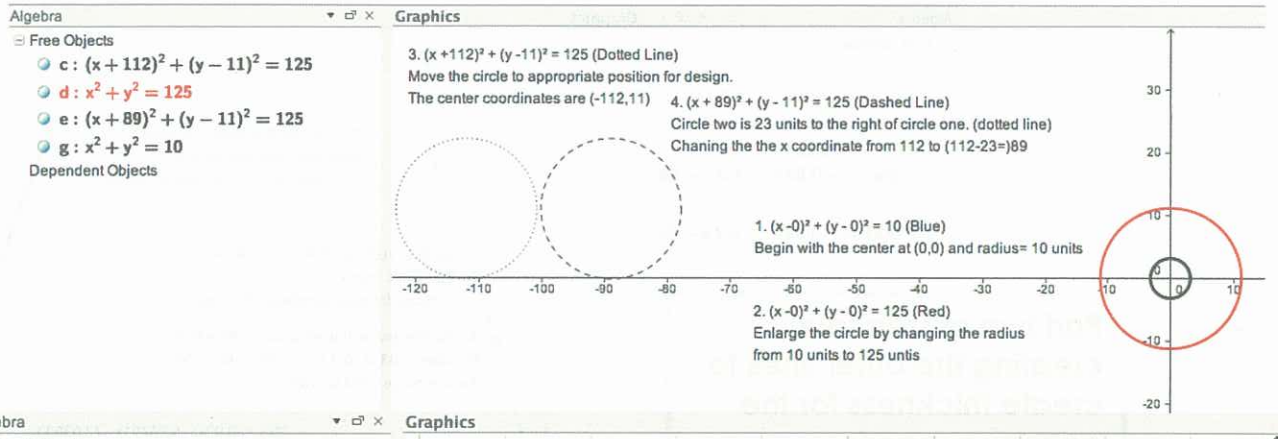
Dependent Objects

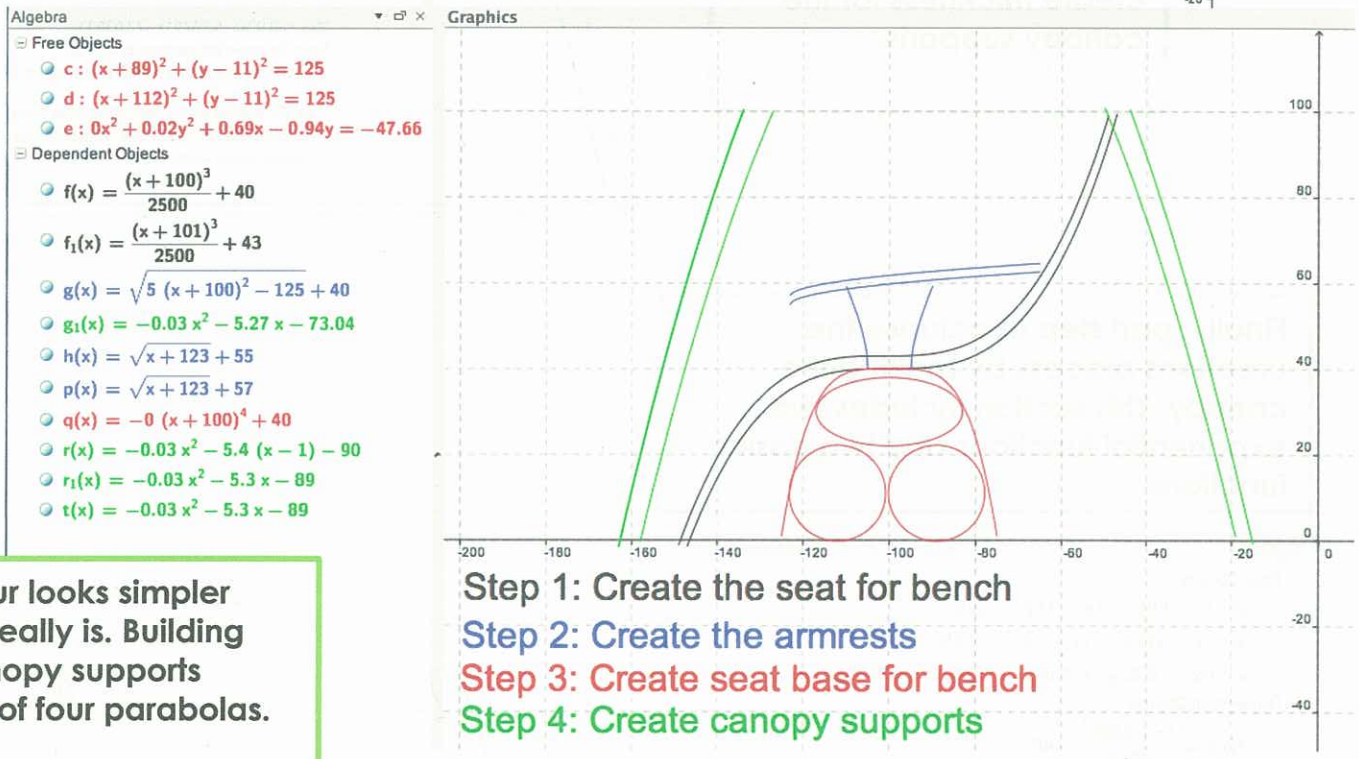
Graphics



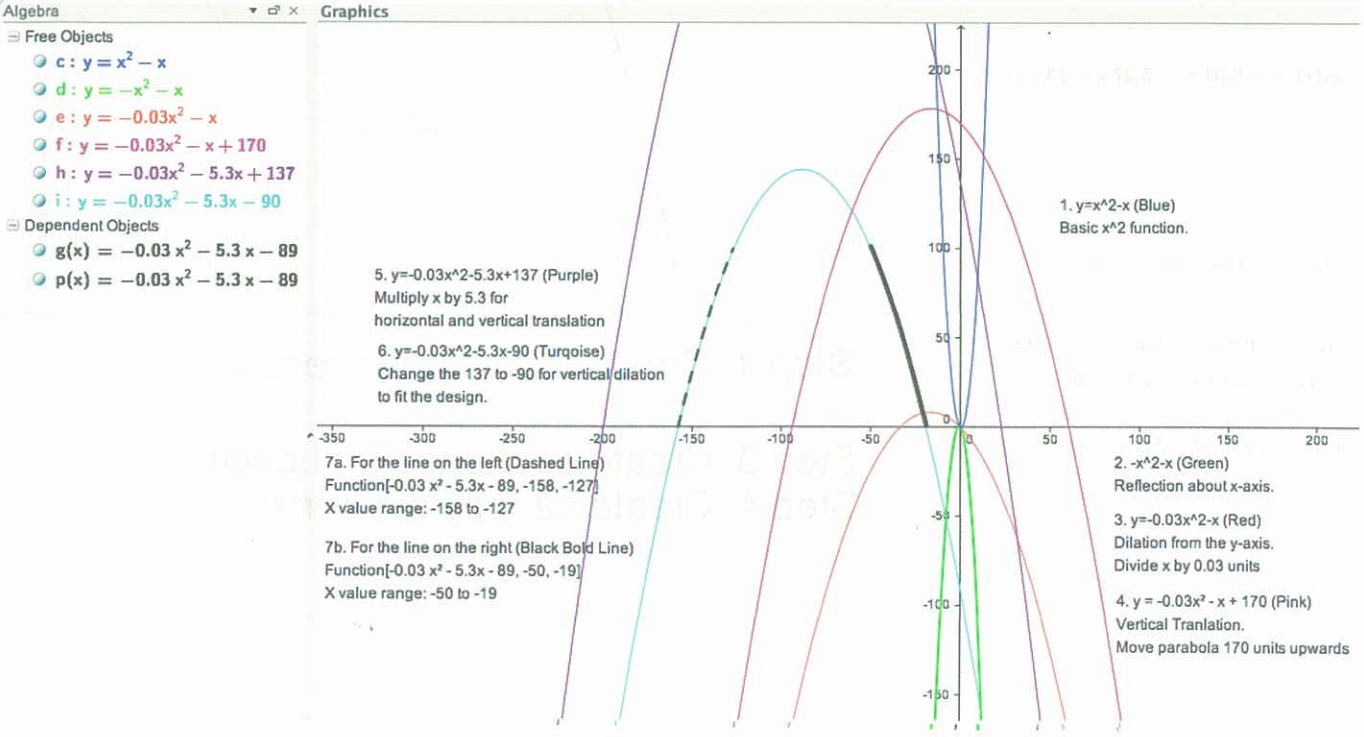
This oval shape is made with the formula:

$(x - h)^2 / a^2 + (y - k)^2 / b^2 = 1$

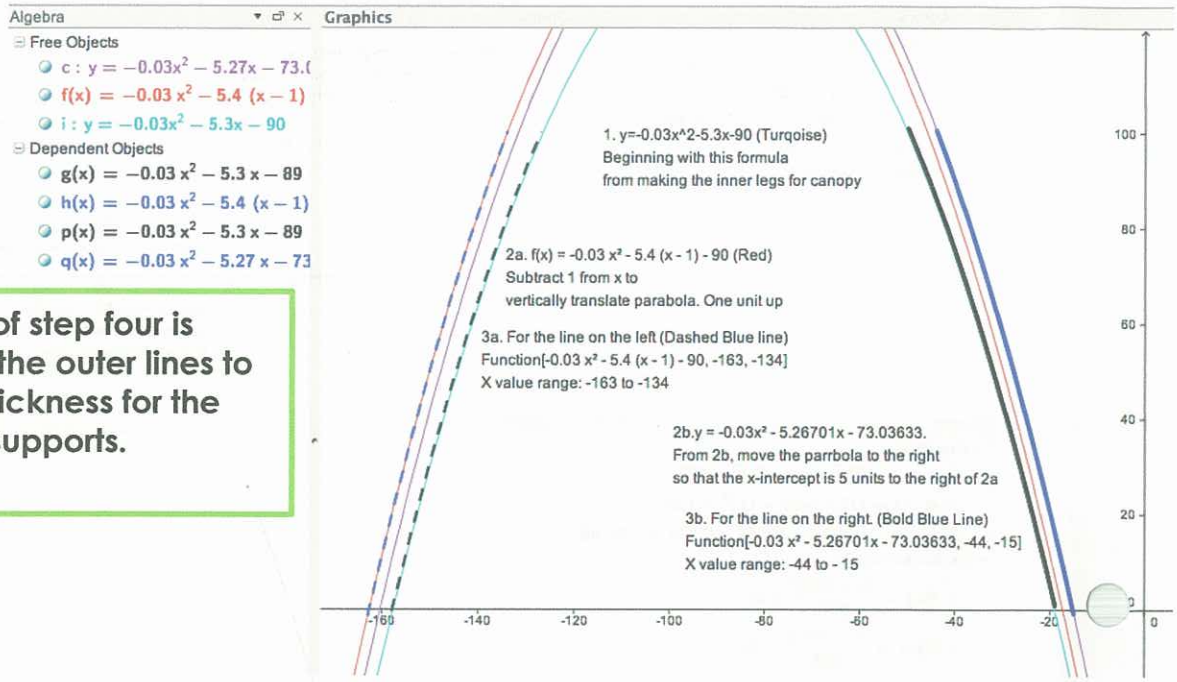




Step four looks simpler than it really is. Building the canopy supports consist of four parabolas. $y=x^2$

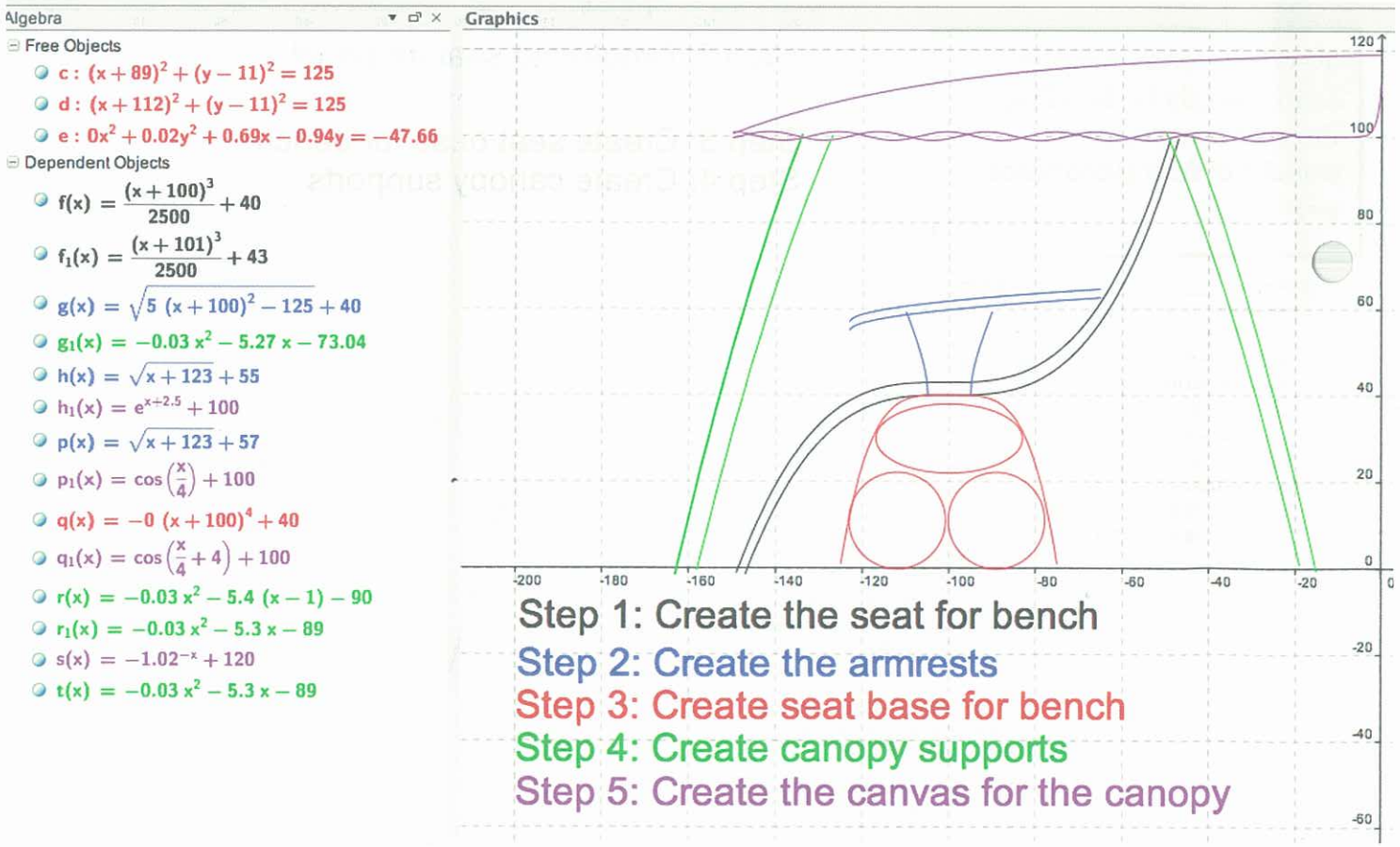


[MATH ASSESSMENT: CANOPY AND WATER BENCH DESIGN
JESSI LUI. Y10 JOY. MS. ECHO LI]



Part two of step four is creating the outer lines to create thickness for the canopy supports.

Finally, part ~~step~~ concludes the creations process by making the canopy. This section includes two exponential functions and two cosine functions.



Algebra

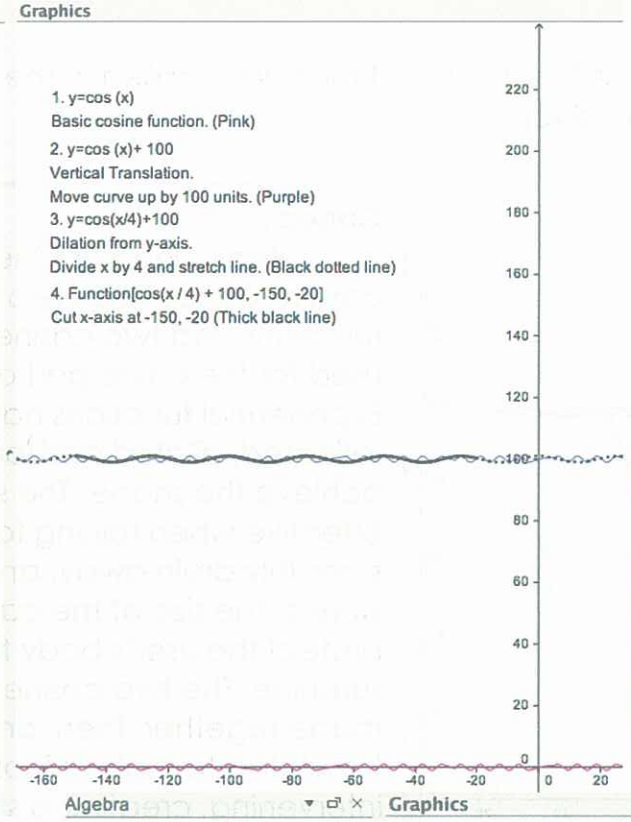
Free Objects

- $f(x) = \cos(x)$
- $g(x) = \cos(x) + 100$
- $h(x) = \cos\left(\frac{x}{4}\right) + 100$

Dependent Objects

- $q(x) = \cos\left(\frac{x}{4}\right) + 100$

Graphics



To commence part 5, start with the two cosine functions.
y= cos(x)
Then, translate and dilate the formula to achieve the wavy pattern.

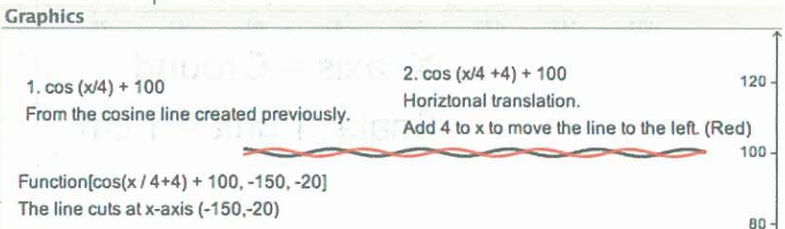
Algebra

Free Objects

Dependent Objects

- $q_1(x) = \cos\left(\frac{x}{4}\right) + 100$
- $q_2(x) = \cos\left(\frac{x}{4} + 4\right) + 10$

Graphics



Algebra

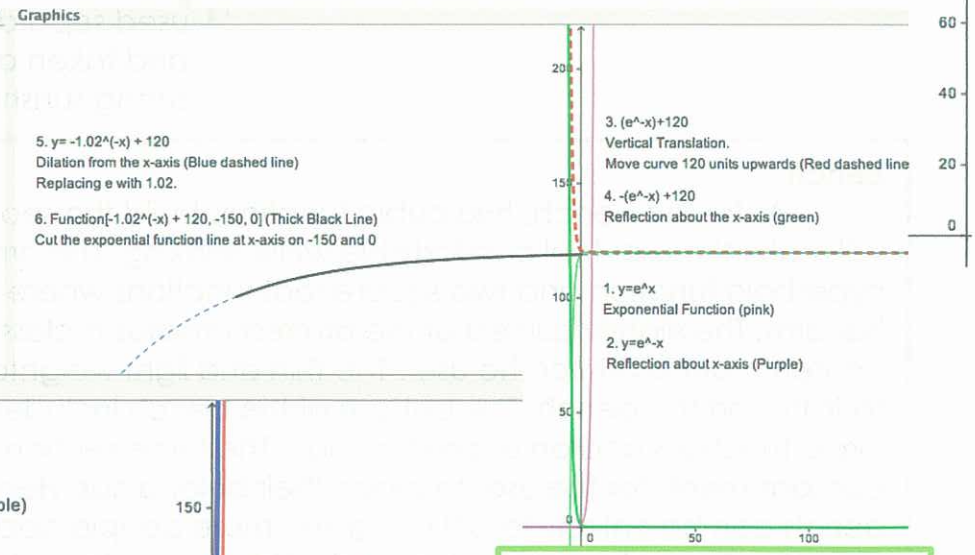
Free Objects

- $f(x) = e^x$
- $h(x) = e^{-x}$
- $j(x) = e^{-x} + 120$
- $k(x) = -e^{-x} + 120$
- $l(x) = -1.02^{-x} + 120$

Dependent Objects

- $g(x) = -1.02^{-x} + 120$

Graphics



Algebra

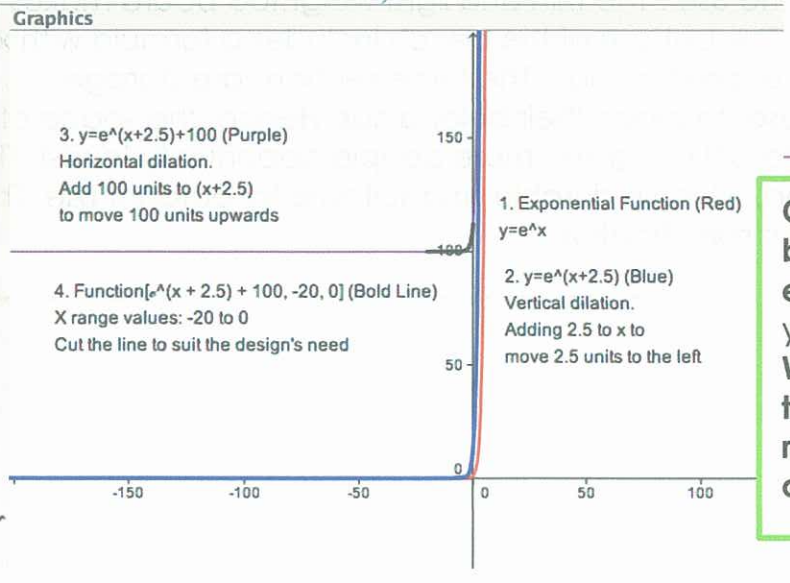
Free Objects

- $g(x) = e^x$
- $h(x) = e^{x+2.5}$
- $r(x) = e^{x+2.5} + 100$

Dependent Objects

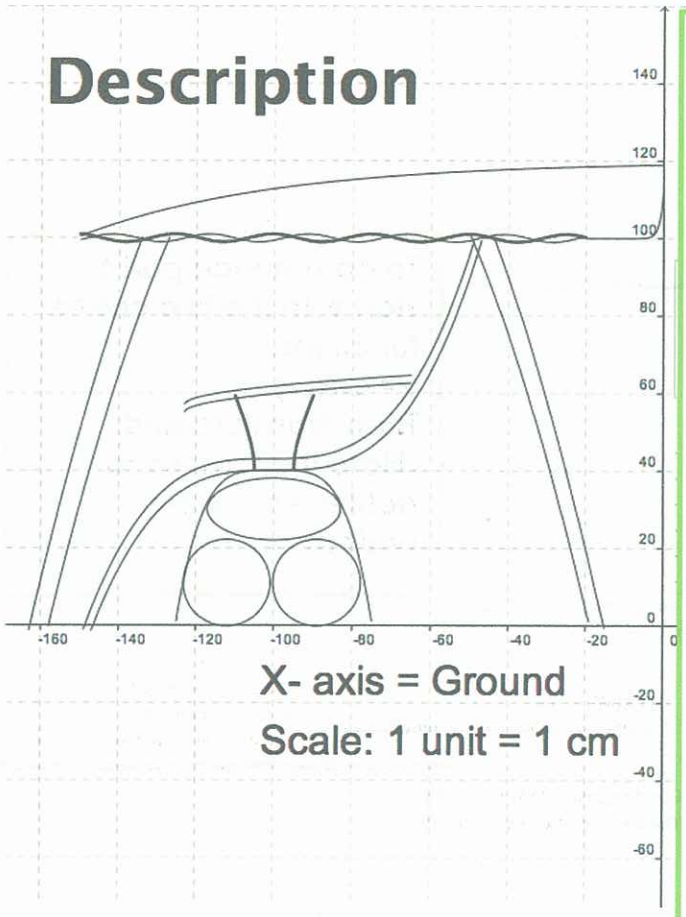
- $f(x) = e^{x+2.5} + 100$

Graphics



Complete the product by adding two exponential formulas:
$y=e^x$
With some dilation, translation and reflection, the canopy is done!

A narrative describing the functions and formulas applied in the design, and other highlights of the product.



Canopy

Beginning from the top, this canvas canopy has two exponential functions and two cosine functions are used for the cover part of the canopy. Exponential functions have to be reflected, dilated and/or translated to achieve the shape. The streamline is effective when raining for water to smoothly drain away, and not be stored. The size of the canopy can protect the user's body from the sunshine. The two cosine functions are made together, then, one vertically translated to make it look like it's intervening, creating a stylish design.

Parabola functions are used for the supports for the canopy. They are four separate parabolas. These supports will be made of steel since they're strong and can be painted into any colour. This canopy can be used separately for other purposes and taken away when there is no strong sunshine or rain.

Bench

As for the bench, two cubic functions build the seat and backrest. Its shape will make the user feel comfortable while relaxing. The armrests are made by a hyperbola function and two square root functions where the user can place his or her arm. The slightly curved of the armrest creates a classic feeling and increases contentment levels for the user. The thin and light weighted board makes it easier to transport the bench. The bottom of the bench includes a formula with x^4, two circle functions and an ellipse function. The three sections are storage compartments for the user to place their belongings. Hence, the space of the bench can be entirely for sitting, giving more people opportunity to rest. This bench is made of acacia wood, which is durable and suitable for outdoor use. This material fulfills the design specification.

This is the final product. All the equations are listed on the left hand side of the graph[1]. Behind this page is the initial design of the bench.

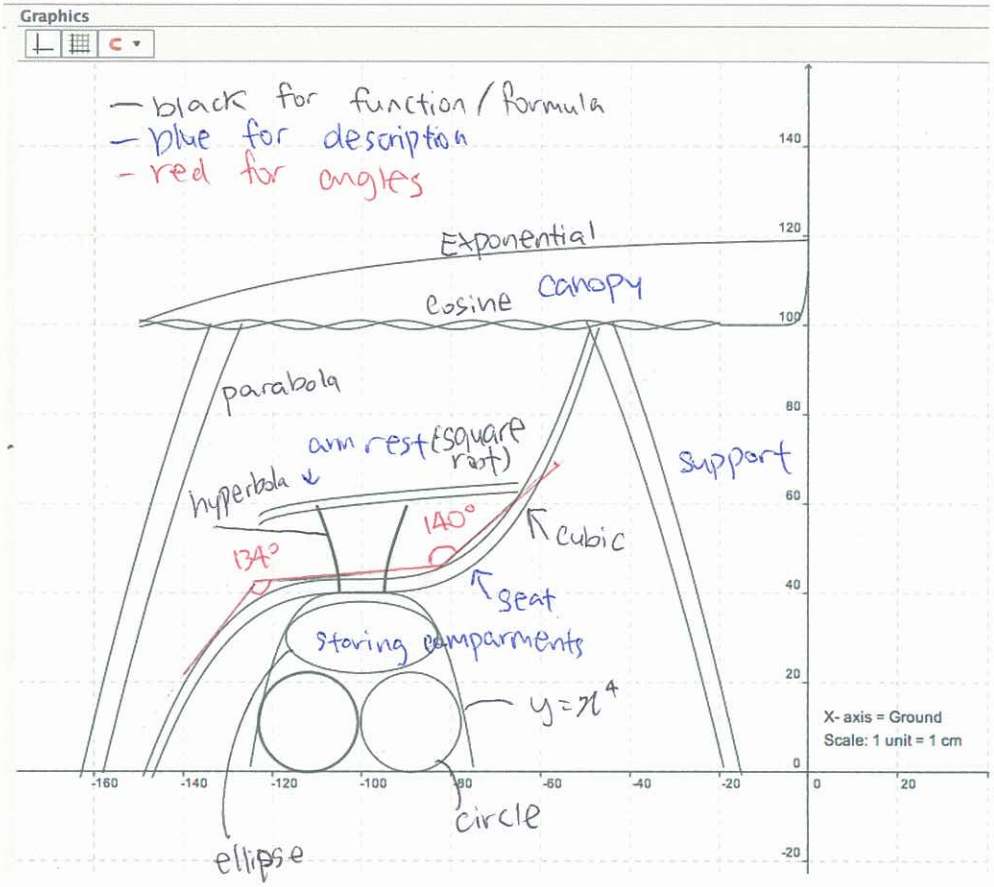
Algebra

Free Objects

- $c: (x+112)^2+(y-11)^2=125$
- $e: (x+89)^2+(y-11)^2=125$
- $s: 0x^2+0.02y^2+0.69x-0.94y=-$

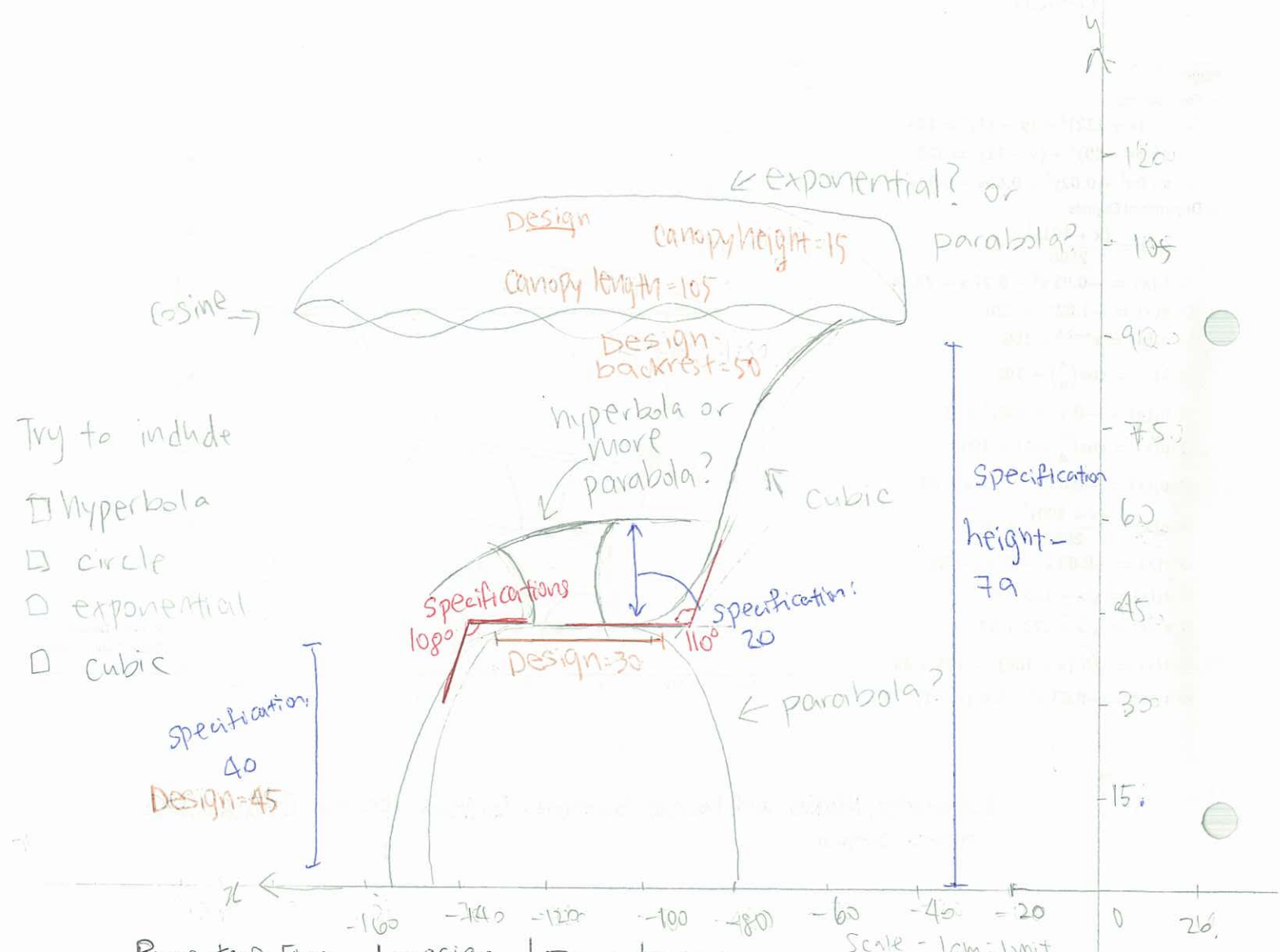
Dependent Objects

- $f(x)=\frac{(x+101)^3}{2500}+43$
- $f_2(x)=-0.03x^2-5.27x-73.04$
- $g(x)=-1.02^{-x}+120$
- $g_1(x)=e^{x+2.5}+100$
- $h(x)=\cos\left(\frac{x}{4}\right)+100$
- $h_1(x)=-0(x+100)^4+40$
- $p(x)=\cos\left(\frac{x}{4}+4\right)+100$
- $p_1(x)=-0.03x^2-5.3x-89$
- $q(x)=\frac{(x+100)^3}{2500}+40$
- $r(x)=-0.03x^2-5.3x-89$
- $r_1(x)=\sqrt{x+123}+55$
- $s_1(x)=\sqrt{x+123}+57$
- $t(x)=\sqrt{5(x+100)^2-125}+40$
- $t_1(x)=-0.03x^2-5.4(x-1)-90$



[1] Hohenwarter, Markus, and Michael Borcherds. Geogebra. Vers.4.0. Geogebra, 2002. Computer Software.

Design of Bench



Percentage Error Backrest	Design (cm) 50	Final (cm) 45	PE(%) 10% |[(45-50)/50]*100| = 10%
Depth (seat)	30	30	0%
height (seat)	45	40	11.1% |[(40-45)/45]*100| = 11.1%
Canopy length	105	150	42.86% |[(150-105)/105]*100| = 42.86%
canopy height	15	20	33.3% |[(20-15)/15]*100| = 33.3%
Armrest height	20	20	0%

Largest differance: canopy length + height

∵ the canopy size is not decided and controlled by the specifications,

∴ it could be modified in the final product to improve the product.

→ canopy's length became longer to keep sun and rain away from user and prevent storing rain

→ canopy's height shortened to save material.

Below is an evaluation of the product against the specifications decided upon earlier. Percentage error has to be calculated to determine the how well the model fits the specification and the accuracy of this design.

Algebra

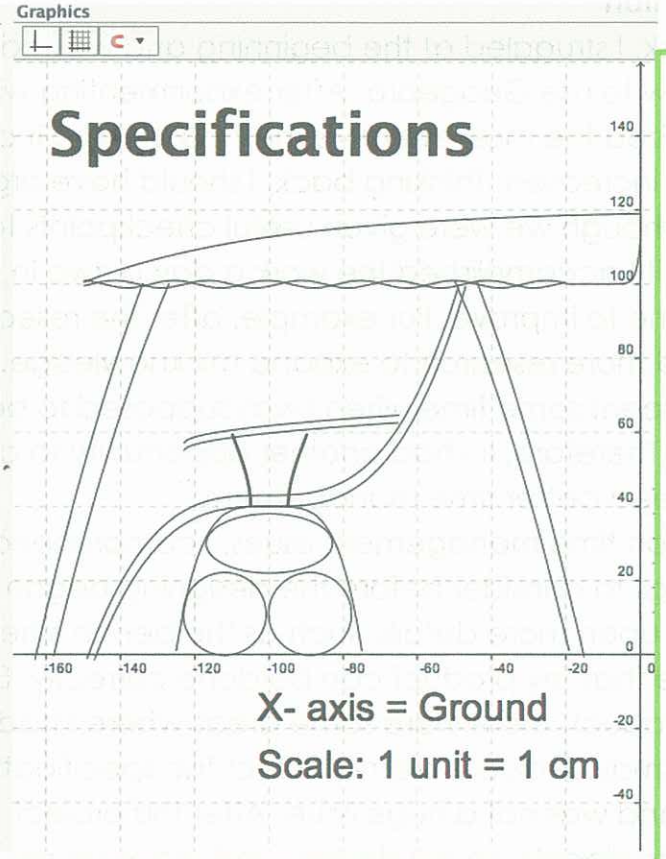
Free Objects

- $c: (x+112)^2+(y-11)^2=125$
- $e: (x+89)^2+(y-11)^2=125$
- $s: 0x^2+0.02y^2+0.69x-0.94y=-47.66$

Dependent Objects

- $f(x)=\frac{(x+101)^3}{2500}+43$
- $f_2(x)=-0.03x^2-5.27x-73.04$
- $g(x)=-1.02^{-x}+120$
- $g_1(x)=e^{x+2.5}+100$
- $h(x)=\cos\left(\frac{x}{4}\right)+100$
- $h_1(x)=-0(x+100)^4+40$
- $=\cos\left(\frac{x}{4}+4\right)+100$
- $p_1(x)=-0.03x^2-5.3x-89$
- $q(x)=\frac{(x+100)^3}{2500}+40$
- $r(x)=-0.03x^2-5.3x-89$
- $r_1(x)=\sqrt{x+123}+55$
- $s_1(x)=\sqrt{x+123}+57$
- $t(x)=\sqrt{5(x+100)^2-125}+40$
- $t_1(x)=-0.03x^2-5.4(x-1)-90$

Graphics



Scale: 1 unit= 1 cm
Equations to apply:
→ Circle $(x-h)^2+(y-k)^2=r^2$
YES (Base)
→ Hyperbola $x^2/a^2-y^2/b^2=1$
YES(Armrest)
→ Parabola $y=x^2$
YES (canopy support)
→ Cubic $y=x^3$
YES (seat and back)
→ Cosine $y=\cos(x)$
YES (canopy design)
→ Exponential Function $y=e^x$
YES (canopy design)
→ Ellipse $(x-h)^2/a^2+(y-k)^2/b^2=1$
YES (Base)

Bench design research:
→ Canopy with wavy designs
(Cosine function)
→ Stylish armrests
(With curves)
→ Seats made of wood
Yes
→ Frame made of steel/ metal
Yes

Percentage Error	Initial Plan (Specification)	Final Product	Percentage Error
Total Height	79cm	100cm	[(100-79)/79]*100= 26.58%
Backrest height	35-40cm (37.5)	45cm	[(45-37.5)/37.5]*100= 20%
Seat height	40-50cm (45)	40cm	[(40-45)/45]*100 =11.1%
Angle for back	100-115°	140°	$\left(\frac{140-107.5}{107.5}\right)\times 100\% = 30.3\%$
Angle for leg	108°	134°	$\left(\frac{134-108}{108}\right)\times 100\% = 24.1\%$
Armrest	20-25cm (22.5)	20cm	[(22.5-20)/22.5]*100=11.1%

In conclusion, the measurements of my final design and numbers in the specifications are most similar. The largest percentage difference is the height, which is 26.58%. I consider that the client would be satisfied with the product because most measurements are very alike and the entire function and aim for comfort with a canopy that can block the sunshine and rain is accomplished. If the client insists, it is possible to decrease the percentage error of the total height and backrest height by cutting the cubic function and change the x values range from -145 to approximately -55. Then, the total height would be about 80cm while the backrest height would decrease to 40 cm.

The angles have the most percentage error and has to be changed if possible, It can be solved by dilation from the y-axis.

Evaluation and Reflection

General Reflection

In this task, I struggled at the beginning and wasted some time on learning how to use Geogebra. After experimenting with the software, I realized the most effective method of using it and the speed of my progress increased. Thinking back, I should have organized my time better. Although we were given useful checkpoints to follow, it would be best if I accomplished the work a day or two in advance so there will be time to improve. For example, after the research is due, I wanted to add more research to expand my knowledge. However, that research spent some time when I was supposed to be designing on Geogebra. Therefore, if I had another opportunity to complete this task, I would need better time management.

Other than time management issues, I comprehended that there was many things to consider before the designing began. I should have decided upon more details, such as the bench's height and width to ensure that my product can be done correctly. Even as I drew out the final product, there were some areas where I had to decide on. However, the small decisions did not affect the specification requirements and was not a huge issue. After this project, I would remind myself to decide on my designs and make up my mind earlier in the future to prevent any hesitant while working.

The three major requirements of comfort, keeping off sun and rain and highly mathematical in shape are all satisfied. Firstly, the lines of my bench are smooth and suit the human body's needs. The dimensions gathered through primary and secondary research guaranteed that human beings would be comfortable resting on the bench. Next, the large canopy applied a shape that can shelter the end-user's body and prevent them from being exposed to the rain or sun. Last but not least, the next section of this reflection will explain how many different formulas are employed in this product.

Mathematical methods used

In my opinion, I have used many higher level and unfamiliar equations for the bench design. Learning about every formula and how each unknown value affects different parts of the design, I gained a lot of knowledge of trigonometry, polynomials and interesting functions from this task. I am confident that this bench is highly mathematical in shape.

Areas of improvement and altering

Reflecting on my final product, I used the specifications to determine whether my design fulfilled the requirements that I showed my client. Most of the criterion was successfully accomplished, with the exception of some measurements. The flaw of my design compared to the specification is the height of the bench. As I haven't decide on whether the canopy is separated or combined with the bench, the bench had to interact with the canopy to ensure there will be support. As a result, the height of the product, along with the backrest is affected. After creating the entire product, I found that it was possible for the canopy to stand with supports and the height of the bench may be altered. If the client gave me more time, I could have improved on that area.

Other than the height, I would also draw more various angles of the bench for my client if more time were given. With more perspectives of the product, my client could understand my design fully and make suggestions to every section.

Moreover, my theme of classic can be worked on. I could add some classic designs, such as lines and shapes to enhance the appearance.

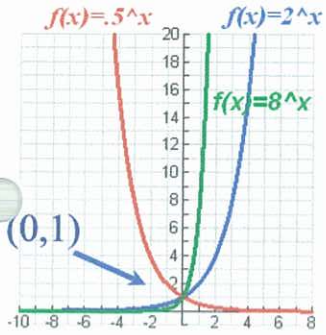
Appendix: Research

Mathematical Functions: Basic, trigonometry and hyperbolic

Basic Knowledge[1]

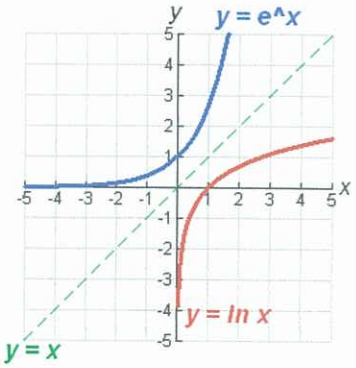
Constants to learn

e Euler's number (base of natural logarithm *ln*); 2.718281828459
pi =π= 3.1415926535898
sq2 Square root of 2; 1.4142135623731
go Golden ratio; 1.6180339887499
d Feigenbaum constant, delta; 4.6692016091030
Square functions are: y= x^ (any number)



Exponential and Logarithm Formula

←Exponential Functions:[2] Exponential graphs of the form $f(x) = b^x$: crosses the y-axis at (0,1). The x-range is always positive real number.
→Inverse function is like a reflection, but on a diagonal.
It uses the key between log and sin on the calculator.



To input the formula: Shift-> Catalog -> logab(... $\log_2 x = y$ ⇔a^y=x
This formula is obtained for **logn** Logarithm to the base n.
ex. **logn(2#x)** logarithm of x to the base 2, $\log_2(x)$

I highlighted ones that I have found and recorded in the GDC calculator.

sin Sine, sinus, ex. **sin(x)**
cos Cosine, cosinus, ex. **cos(x)**
tan Tangent, ex. **tan(x)**
cot Cotangent, ex. **cot(x)**
sin2 Sine square, ex. **sin2(x)**
cos2 Cosine square, ex. **cos2(x)**
tan2 Tangent square, ex. **tan2(x)**
cot2 Cotangent square, ex. **cot2(x)**
asin Arcsine, ex. **asin(x)**
acos Arccosine, ex. **acos(x)**
atan Arctangent, ex. **atan(x)**
acot Arccotangent, ex. **acot(x)**
sinh Hyperbolic Sine, ex. **sinh(x)**
cosh Hyperbolic Cosine, ex. **cosh(x)**
tanh Hyperbolic Tangent, ex. **tanh(x)**
coth Hyperbolic Cotangent, ex. **coth(x)**
asinh Area Hyperbolic Sine, ex. **asinh(x)**
acosh Area Hyperbolic Cosine, ex. **acosh(x)**
atanh Area Hyperbolic Tangent, ex. **atanh(x)**
acoth Area Hyperbolic Cotangent, ex. **acoth(x)**
sca Secant, ex. **sca(x)**
csc Cosecant, ex. **csc(x)**
asca Arcsecant, ex. **asca(x)**
acsc Arccosecant, ex. **acsc(x)**
scah Hyperbolic Secant, ex. **scah(x)**
csch Hyperbolic Cosecant, ex. **csch(x)**
arscah Area Hyperbolic Secant, ex. **arscah(x)**
arcsch Area Hyperbolic Cosecant, ex. **arcsch(x)**
abs Absolute values, ex. **abs(x).** Looks like y=|x| and creates V shapes.

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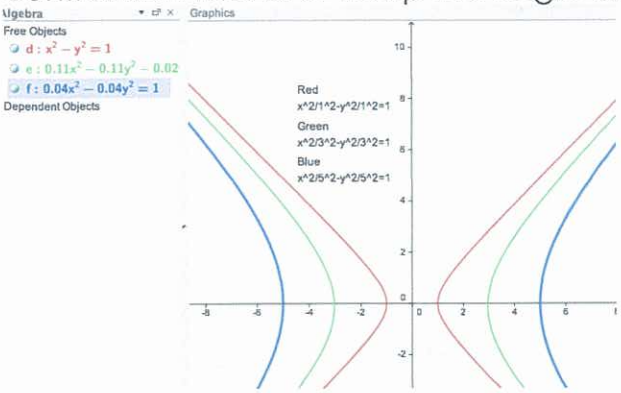
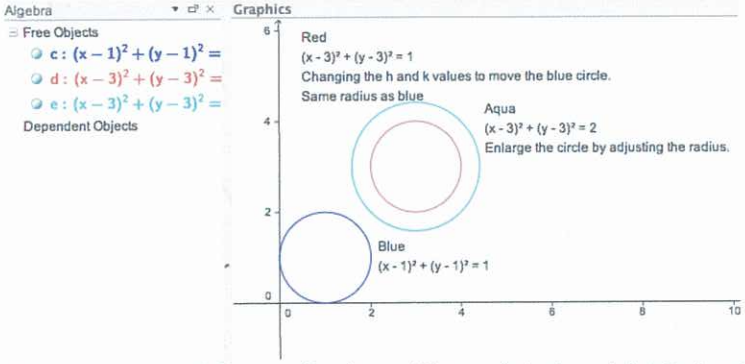
[1]"Free graphing calculator online : plot a graph online for free - graph an equation f(x) with exponent, trigonometry,..." Online graph plotter is a free graphing calculator to trace a function online. 25 Sept. 2011 <http://graph-plotter.cours-de-math.eu/instructions.html>.
[2]Roberts, Donna. "Exponential Functions." Oswego City School District Regents Exam Prep Center. 25 Sept. 2011 <http://www.regentsprep.org/Regents/math/algtrig/ATP8b/exponentialFunction.htm>.

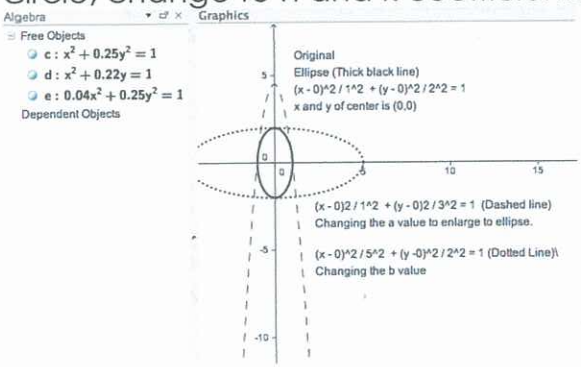
The standard formula for a hyperbola is[3]: $x^2/a^2-y^2/b^2=1$. The shape is two boomerang shaped like this: > <. The purpose of coordinates a and b are to control how round or sharp the angle is. I tried this on GeoGebra.[4]



The standard formula for circle is[5]: $(x-h)^2+(y-k)^2=r^2$ The h and k are (x,y) coordinates of a circle's center. The r is the radius of the circle. Therefore, to alter the size of the circle, adjust the r coefficient. To move the circle, change to h and k coefficients. Below are the experiments with circles on GeoGebra.



The standard formula for ellipse is[6]: (x - h)^2 / a^2 + (y -k)^2 / b^2 = 1
Just like circle, the h and k are (x,y) coordinates of an ellipse's center. Therefore, to alter the size of the circle, adjust a or b coefficient. To move the circle, change to h and k coefficients. Geogebra experiments is shown here:



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[3] A Dendane. "Equation of Hyperbola - Applet." *Free Mathematics Tutorials, Problems and Worksheets (with Applets)*. 03 Apr. 2011. Web. 26 Sept. 2011. <http://www.analyzemath.com/EquationHyperbola/EquationHyperbola.html>.

[4] Hohenwarter, Markus, and Michael Borcherds. *GeoGebra*. Vers. 4.0. GeoGebra, 2002. Computer software.

[5] A Dendane. "Equation of a Circle." *Free Mathematics Tutorials, Problems and Worksheets (with Applets)*. 03 Apr. 2011. Web. 26 Sept. 2011. <http://www.analyzemath.com/CircleEq/CircleEq.html>.

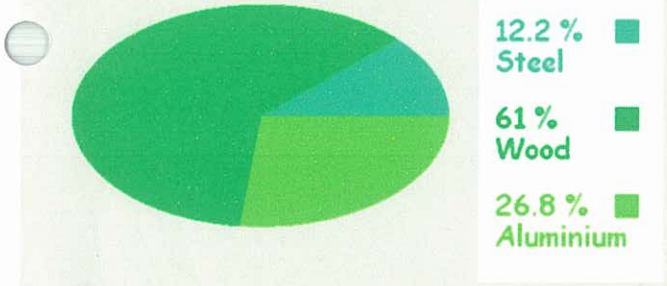
[6] A Dendane. "Equation of Ellipse." *Free Mathematics Tutorials, Problems and Worksheets (with Applets)*. 03 Apr. 2011. Web. 26 Sept. 2011. <http://www.analyzemath.com/EllipseEq/EllipseEq.html>.

INTERVIEW RESPONSE- TOTAL SURVEYS ANSWERED: 41

The bold response is the most popular results among all the answers in every question.

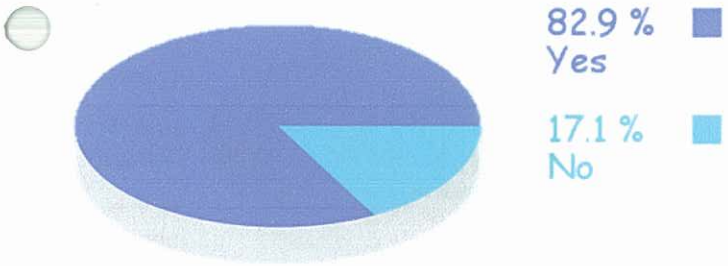
1. What material would you like a water front bench to be made of?

	Response Percent	Response Count
Steel	12.2%	5
Wood	**61.0%**	**25**
Aluminium	26.8%	11



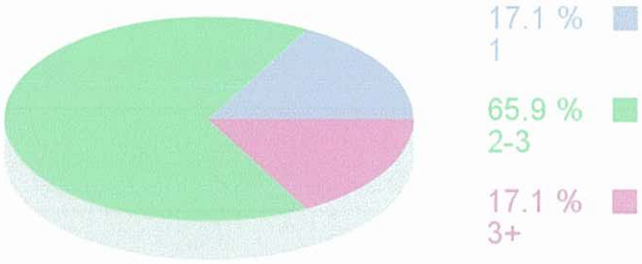
2. Should there be armrests for a water front bench?

	Response Percent	Response Count
Yes	**82.9%**	**34**
No	17.1%	7



3. Should there be backrest for a water front bench?

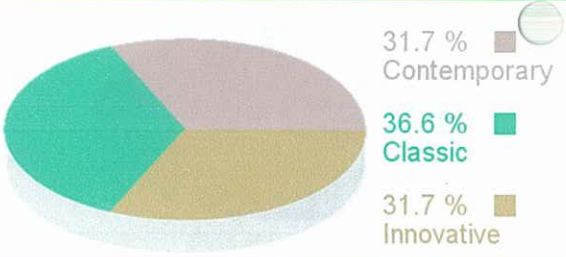
	Response Percent	Response Count
Yes	**95.1%**	**39**
No	4.9%	2



4. Select the number of users for a water front bench.

	Response Percent	Response Count
1	17.1%	7
2-3	**65.9%**	**27**
3+	17.1%	7

5. Select the preferred design/style for a water front bench.



	Response Percent	Response Count
Classic	**36.6%**	**15**
Contemporary	31.7%	13
Innovative	31.7%	13

Analysis and description	Image
This design is simple but has features such as canopy and arm rests to make it comfortable. The ends of the armrest also have cup holders to place a cup of coffee while relaxing.[1]	
This bench is special because it is for relaxation and fun. It is a swing for the users to move on. In addition, there is a stable side rest on the sides to put drinks and a canopy to block the rain or sunshine. The bench is made of wood.[2]	
Made of steel frame and redwood seat, this bench is simple in design and very spacious for many people to use at the same time. It has a canvas canopy, slightly designed with curvy lines. It is most suitable for outdoor use and helps block sunshine.[3]	
This bench, named El Filosofo, is for outdoors and indoors use. There are three sections, with two single seats and one family seat. The user can choose whether they want to share with others or have some alone time.[4]	

[1] "Pier Pleasure Dock Accessories - Bench Canopies and Arm Rest with Cup Holder." Pier Pleasure - Quality Aluminum Piers, Sectional Docks, Roll-In Docks and Lifts. Pier Pleasure. 25 Sept. 2011 <http://www.pierpleasure.com/accessories/bench_canopy.htm>.

[2] Trueshopping. "Hardwood Frame 2 Seat Garden/Patio Swing Bench Seat with Green Sunshade: Amazon.co.uk: Garden & Outdoors." Amazon.co.uk: Low Prices in Electronics, Books, Sports Equipment & more. 25 Sept. 2011 <http://www.amazon.co.uk/Hardwood-Frame-Garden-Patio-Sunshade/dp/B0027TX7DO>.

[3] "J.A.C 3330 - 3330 - Canopies with Benches/Tables - Suntrends Cabana Bench 10'"MistralFitness.com. Mistral Fitness. 25 Sept. 2011 <http://www.mistralfitness.com/pd-catid-73-productid-1417.htm>.

[4] "El Filosofo Bench – Unique Public Furniture from Bd Barcelona Design / Home Trends | Decoration | Gardening." Home Trends | Decoration | Gardening. 06 Dec. 2008. 25 Sept. 2011 <http://www.momoy.com/2008/12/06/el-filosofo-bench-unique-public-furniture-from-bd-barcelona-design/>.

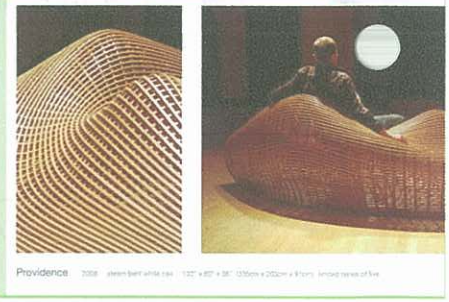
The stylish armrests and legs of chair can be applied in my design. They are curly and good-looking, which attracts the user's attention. The backrest has engraved designs so the product would be more fascinating.

An aqua blue water front bench is ideal for a summer's day. I like the design of the backrest. This line will be challenging but interesting to create. Also, similar to many benches, this bench has strips of wood horizontal for the seat and vertical wood for the backrest.[5]

This steel bench is durable and stylish. Its back design is especially captivating with circle shapes and wavy lines. It is almost like a picture painted onto the bench.[6]

A butterfly bench is really inspiring and original. The parts where there are many abstract shapes in the backrest has both functional and aesthetics purposes. On a hot day, it would be more comfortable for the user.

Inspired by lines and made of wood, these benches apply the most conceptual design but serve a purpose of a bench and looks extremely comfortable. I can learn to use the thick and thin lines while designing. It suits different people's needs.[7]



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[5] "Deck bench." Patio Furniture, Outdoor Decor, Garden Supplies, Fire Pits, Benches, Chairs, Tables, Fountains. 25 Sept. 2011 <http://www.outbackpatio.com/deckbench.html>.
[6] "Mariner Decorative Bench | Metal | Park Benches | Belson Outdoors." Belson Outdoors | Your Outdoor Superstore! | Picnic Tables | Park Benches | Trash Receptacles | Barbecue Grills. Belson Outdoors. 25 Sept. 2011 <http://www.belson.com/mariner.htm>.
[7] Pliessnig, Matthias. "Sit." Matthias Pliessnig. 2009. 25 Sept. 2011 <http://matthias-studio.com/sit/sit.html>.

MATH ASSESSMENT 1- WATER FRONT BENCH DESIGN

RESEARCH: FURNITURE SHOP VISIT

Ikea is the largest international furniture retailer selling ready-to-assemble furniture such as chairs, beds for indoor and outdoor use. They have several stores in Hong Kong, displaying furniture designed and created in other countries of the world. Below are benches that could be used on the waterfront with their dimensions as reference.

Image	Material	Size [User(s)]	Design
 [1]	Frame: Steel, Polyester powder coating Seat/ Back: Polypropylene plastic, Polyethylene plastic	Width: 70 cm Depth: 78 cm Height: 71 cm Seat width: 70 cm Seat depth: 55 cm Seat height: 39 cm (1-2)	• Hand-woven plastic rattan; weather-resistant and easy to care for. • A seating series that allows you to create combinations according to your own needs and ideas.
 [2]	Solid acacia Acrylic paint	Width: 114 cm Depth: 66 cm Height: 73 cm Seat width: 114 cm Seat depth: 40 cm Seat height: 35 cm (2-3)	• Back with ledge that can be used as a utility surface or to rest your arm on. • Hand hole in the back for easy mobility.
 [3]	Frame: Aluminum, Polyester powder coating Slat: Polystyrene plastic Feet: Polyamide plastic	Width: 59 cm Depth: 61 cm Height: 86 cm Seat width: 42 cm Seat depth: 44 cm Seat height: 43 cm (1)	• Polystyrene slats; weather-resistant and easy to care for. • Rustproof aluminium frame; both sturdy and lightweight.

---

[1] "AMMERÖ One seat section with cushion - IKEA." Welcome to IKEA.com - IKEA. 25 Sept. 2011 <http://www.ikea.com/hk/en/catalog/products/70165752/>.

[2] "VÄDERÖ Bench - IKEA." Welcome to IKEA.com - IKEA. 25 Sept. 2011 <http://www.ikea.com/hk/en/catalog/products/30165117/>.

[3] "FALSTER Chair with armrests - IKEA." Welcome to IKEA.com - IKEA. 25 Sept. 2011 <http://www.ikea.com/hk/en/catalog/products/30203826/>.

Jessi Lui. 10 Joy. Ms. Echo Li.

MATH ASSESSMENT 1- WATER FRONT BENCH DESIGN

RESEARCH: FURNITURE SHOP VISIT

 4	Frame: Steel, Polyester powder coating Seat/ Back: Solid acacia, Acrylic paint	Width: 119 cm Depth: 55 cm Height: 85 cm Seat width: 113 cm Seat depth: 38 cm Seat height: 46 cm (2-3)	• Simple lines, but comfortable to use. • Light because of few materials used.
 5	Solid acacia Oil	Width: 117 cm Depth: 65 cm Height: 80 cm Seat width: 115 cm Seat depth: 52 cm Seat height: 42 cm (2-3)	• Solid acacia; durable hardwood for outdoor use. • Body-contoured back for great comfort.
 6	Frame: Aluminium, Polyester powder coating Slat: Polystyrene plastic Feet: Polyamide plastic	Width: 130 cm Depth: 36 cm Height: 43 cm Seat width: 130 cm Seat depth: 36 cm Seat height: 43 cm (3-4)	• Polystyrene slats; weather-resistant and easy to care for. • Rustproof aluminium frame; both sturdy and lightweight.

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[4] "MÄLARÖ Bench - IKEA." Welcome to IKEA.com - IKEA. 25 Sept. 2011 <http://www.ikea.com/hk/en/catalog/products/40165131/>.

[5] "ÄPPLARÖ Bench - IKEA." Welcome to IKEA.com - IKEA. 25 Sept. 2011 <http://www.ikea.com/hk/en/catalog/products/90164544/>.

[6] "FALSTER Bench - IKEA." Welcome to IKEA.com - IKEA. 25 Sept. 2011 <http://www.ikea.com/hk/en/catalog/products/50203825/>.

MATH ASSESSMENT 1- WATER FRONT BENCH DESIGN

RESEARCH: FURNITURE SHOP VISIT

Information analysis:

Examining the different bench, I realized the width for benches with:

Person (People)	Width (cm)
1	42-70
2-3	110-120
3-6	130-210

There are two measurements for the depth, one including the back and the other one just for seat.

Depth of benches (on average): 60.17cm

Seat depth of benches (on average): 44.17cm

A comfortable depth: 50cm

Height of entire product (on average): 79cm

Seat Height (on average): 41.3 cm

The seat height is the height from the ground to the surface where users sit.

Backrest (on average): 37.8 cm

The backrest is only from the surface where the user sits to the top point of the board.

Material usage analysis
Frame: Steel, Polyester powder coating Seat/ Back: Polypropylene plastic, Polyethylene plastic
Solid acacia Acrylic paint
Frame: Aluminum, Polyester powder coating Slat: Polystyrene plastic Feet: Polyamide plastic
Frame: Steel, Polyester powder coating Seat/ Back: Solid acacia, Acrylic paint
Solid acacia Oil
Frame: Aluminium, Polyester powder coating Slat: Polystyrene plastic Feet: Polyamide plastic
Therefore, **Frames most apply steel, acacia, and aluminum.** **Material for seat and backrest: Plastic, acacia.**

Design Analysis
A back with ledge can increase the comfort level of target audiences to rest their arms or neck. **Leaving spaces in suitable places of the backrest can convenient and nice-looking.**
Aluminum is a sturdy and light-weigh material. **Solid acacia is good for outdoor use.**
Adjusting the angle for backrest could escalate comfort levels.
Polystyrene is a weather-resistant material, useful for outdoor furniture.

Sitting and Chair Design[1]

The ergonomics of chair design should be investigated in order to create a bench that is comfortable and beneficial to back development. If chairs are not designed well, the user will sense postural stress and fidget in response.

The total body weight is transferred to the floor through different sections of the chair. They include the seat, chair feet, armrests, and backrests.

Although there is no particular sitting position, there are three different type of sitting postures. The first one: Anterior is where the person leans forward and sits the way at deskwork. Then, there is relax and unsupported position where the back is mostly straight, like the position at movies. Finally, the posterior position is leaning backwards for resting. A chai for resting is relatively larger, inclined with backrests.

Seat Design Criteria.

The height of a seat should be same as shrank length to prevent leg swelling. A website states that **chair's height** should be at least **38cm**, **43cm** being the ideal height. If the chair is too high, it will decrease blood circulation and increase pressure on the nerves.

For the user to use the backrest comfortably, the **seat depth** should be **41cm**. Having seat contouring distributes the pressure over a larger area to ensure comfort. The **width of a person's chair** should be at least **50cm.**

Armrests: provide extra support and are helpful when standing up and sitting down. It should be **20-25cm above the seat** surface height and at least **43cm apart**. (For a single-person seat)

Backrests: The higher the backrest, the more support is given to the user. A high-level backrest fully supports the head and neck, like the airplane seats, and is not necessary for waterfront benches. A medium-level backrest gives shoulder support and maybe as high as **65cm**. A water front bench is probably middle-level height for backrest.

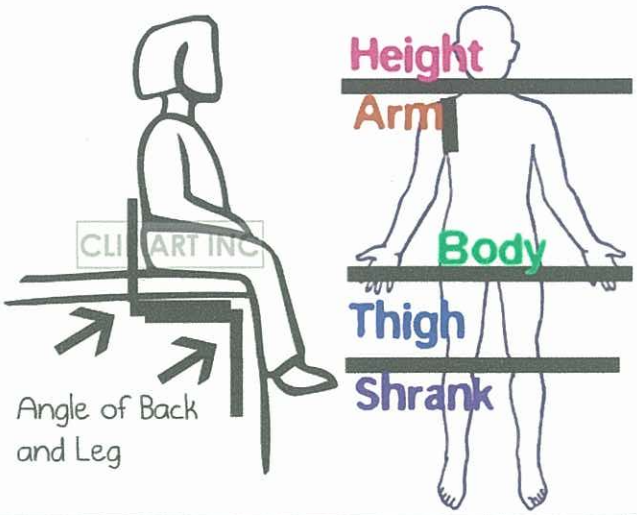
From studies, the **preferred seat angle** is 90+15˚ backwards. However, another study suggests that having the backward angle 90+13-15˚ is the perfect and minimizes the pressure on intervertebral discs. The optimal seat angles should be **100-110˚**.

---

[1] Stensland, Jan. "Ergonomics of sitting." Cornell University Ergonomics Web. Cornell University Ergonomics Web. 25 Sept. 2011 <http://ergo.human.cornell.edu/DEA3250notes/sitting.html>.

MATH ASSESSMENT 1- WATER FRONT BENCH DESIGN. **RESEARCH: BODY DIMENSIONS**

To have specific dimensions for the backrest, arm rest and seat width, there will be the measuring of:
Body Dimensions- Heights, arm, body, thigh, shrank.
Angle between (ankle) (hips) (neck)



Age	Height (cm)	Arm (cm)	Body (cm)	Leg- Thigh (cm)	Leg- Shrank (cm)	Angle ° (Back)	Angle ° (Leg)
15	167	69	62	40	49	108°	90°
15	167	73	44	50	53	101°	88°
15	157	65	~~57~~	42	44	130	100°
15	174	73	68	52	54	130°	110°
15	164	70	65	56	60	130°	120°
15	163	66	60	50	51	100°	135°
15	160	70	55	44	50	120°	100°
16	155	~~65~~	65	50	50	120°	100°
15	174	82	60	52	57	110°	120°
~~10~~ 14	172	71	60	52	54	105	132°
15	164	68	60.	~~49~~	50	110°	85°
Average: 15	165.2	70.2	59.6	48.8	51.1	114.8°	107.3°

MATH ASSESSMENT 1- WATER FRONT BENCH DESIGN

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Specifications

Scale: 1 unit= 1 cm

Equations to apply:
→ Circle $(x-h)^2+(y-k)^2=r^2$
→ Hyperbola $x^2/a^2-y^2/b^2=1$
→ Parabola $y=x^2$
→ Cubic $y=x^3$
→ Cosine $y=\cos(x)$
→ Exponential Function $y=e^x$
→ Ellipse (x - h)^2 / a^2 + (y -k)^2 / b^2 = 1

Bench design research:
→ Canopy with wavy designs
→ Stylish armrests
→ Seats made of wood
→ Frame made of steel/ metal

Based on results from questionnaire:
→ Material: Wood [Solid acacia]
→ Armrest: Yes
→ Backrest: Yes
→ Number of users: 2-3
→ Style: Classic

Dimensions from Ikea research:
→ Width: 110-120cm(two people)
→ Depth of bench: 60 cm (for comfort)
→ Seat Depth/ Height: 45-50/41.3 cm
→ Height: 80cm
→ Backrest: 35-40cm

Primary research- Body Dimensions: [Average]
→Height: 165.2cm
→Arm: 70.2 cm [Armrest]
→Body: 59.6cm [Backrest]
→Leg- Thigh: 48.8cm [Seat Depth]
→Leg- Shrank: 51.1
→ Preferred angle for back: 114.8°
→ Preferred angle for leg: 107.3°

From research (Ikea, body dimensions, ergonomics):

→ Width: 100-120 cm (N/A for side view)
→ Depth: 50-60cm (N/A for side view)
→ Total Height: 79cm
→ Backrest height: 35-40cm
→ Seat height: 40-50cm
→ Angle for back: 100-115°
→ Angle for leg: 108°
→ Armrests: 20-25cm above seat

Ergonomics research:
→ Chair height: 38-43 cm
→ Seat depth: 41cm (at work, so N/A in this task)
→ Width of chair: 50cm(one person, therefore 100cm in this task)
→ Armrests: 20-25cm above seat
→ Angle of seat: 100-110°